WEATHER & THE WAR ON HAIL

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No Band-Aids

- We can forecast hail-weather "favorable conditions"
- We can often forecast the hail event (short lead time)
- We have not been able to prevent hail*
- We MUST mitigate against hail's IMPACT

* Russian scientists claim some success

Mitigation Against Hail!

"Steve's Dream World" Hail Mitigation In Hail Prone Areas

- 1) For new housing- offer only hail resistant options, reward best choices
- 2) Replacing worn out roofs- offer only hail resistant options, reward best choices
- 3) When replacing hail-damaged roofs- offer only hail resistant options, reward best choices
- 4) Develop dent-resistant automobiles as the only consumer options, reward best choices*
- 5) Do nothing:
  - a) "hope" against nature that no hail comes
  - b) raise insurance rates to cover hail risk
  - c) buy-down high risk rates using low risk areas
  - d) "hope" reinsurance rates don't rise

Green Sky A Hail Indicator

Russian Anti-Hail Rocket Launch

(radio or phone remote trigger from - *Abshaev et. al, 2010*)

Fig. 1. Automatic anti-hail rocket launcher "Elia-2

Russian Anti-Hail Rocket

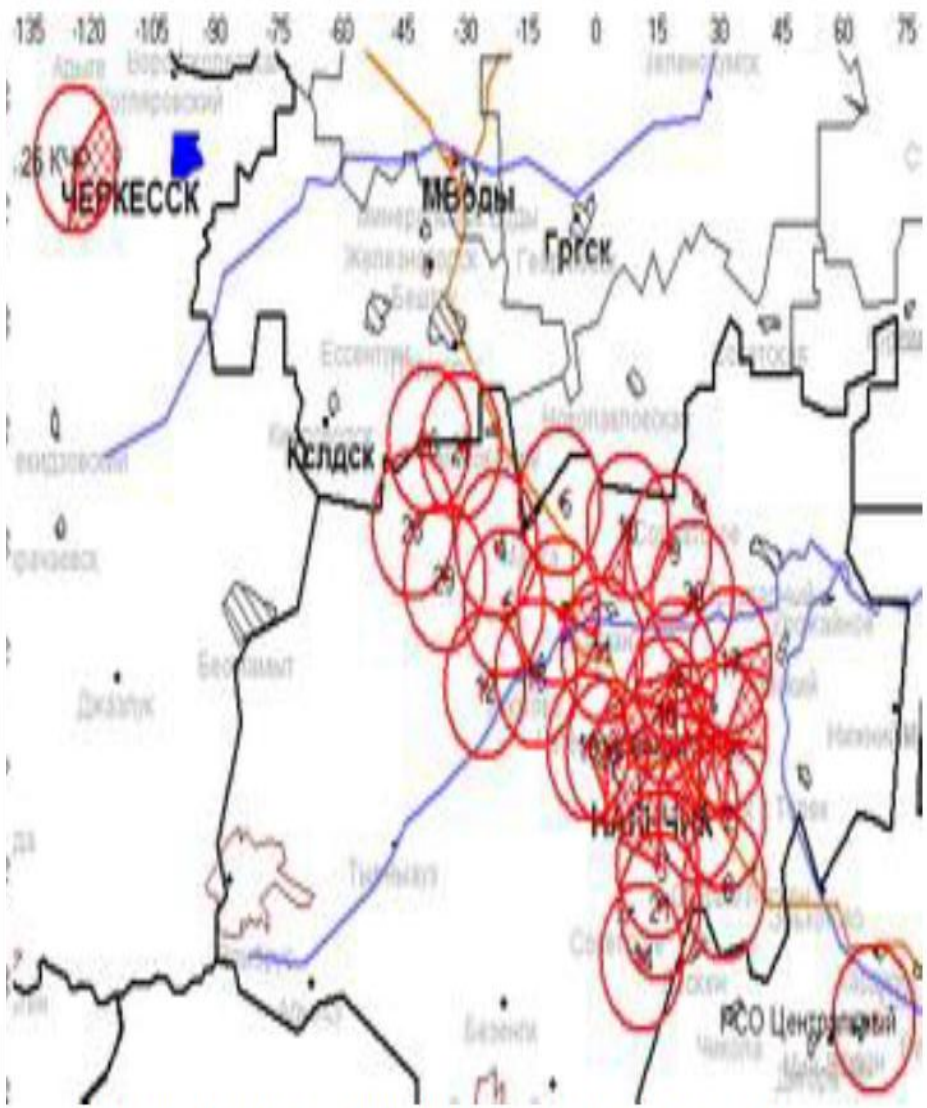


Fig. 4. Position of RL “Elia-2” (red circles) of the Northern Caucasus Anti-hail Service

Also Other Countries in 2010

(from Farazoulis)

International Collaboration

- **WMA** in the field of weather modification
- **Cyprus** in the field of Agr. Insurances
- **Serbia** in the field of Active Protection
- **AIAG** in the field of Agr. Insurances
- **Austria** in the field of Airborne Cloud Seeding
- **Italy** for Civil Protection
- **Spain** in the field of Cloud Seeding by Ground Means
- **Argentina** in the field of weather modification
- **Bulgaria & Croatia .... it's coming soon**

George N. Farazoulis /
ELGA/GREECE

Indicative list

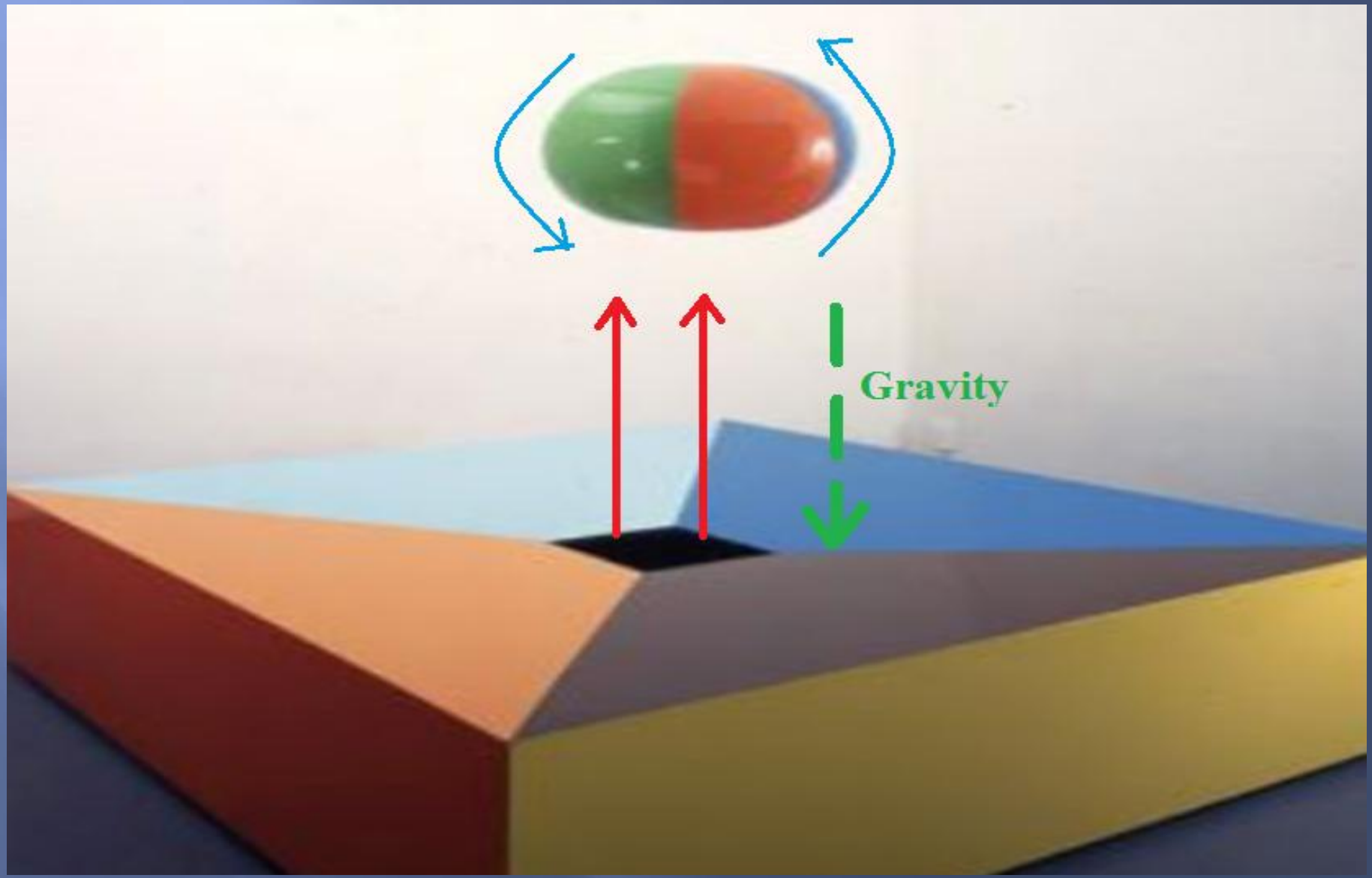
National Hail Research Experiment

In 1971, amid amazing claims of success in the suppression of hail by Soviet scientists the National Hail Research Experiment (NHRE) was inaugurated at NCAR-

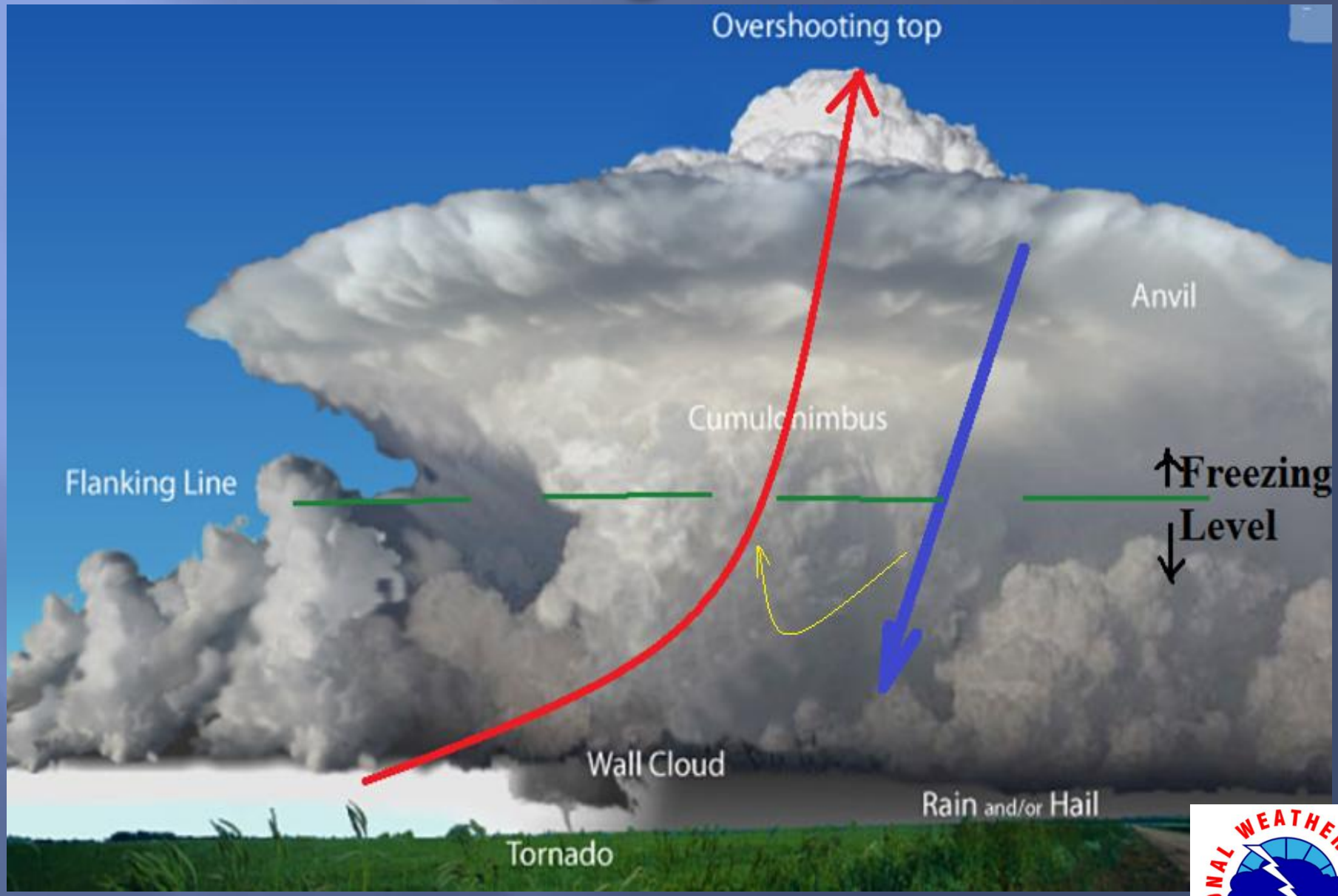
Test hail suppression & better understand summer storms in "Hail Alley"--northeast Colorado, northwest Kansas, southeast Wyoming, and southwest Nebraska.

RESULTS NOT CONCLUSIVE & NEGATIVE

If updraft speed equals or exceeds fall velocity of an object it will remain suspended or rise



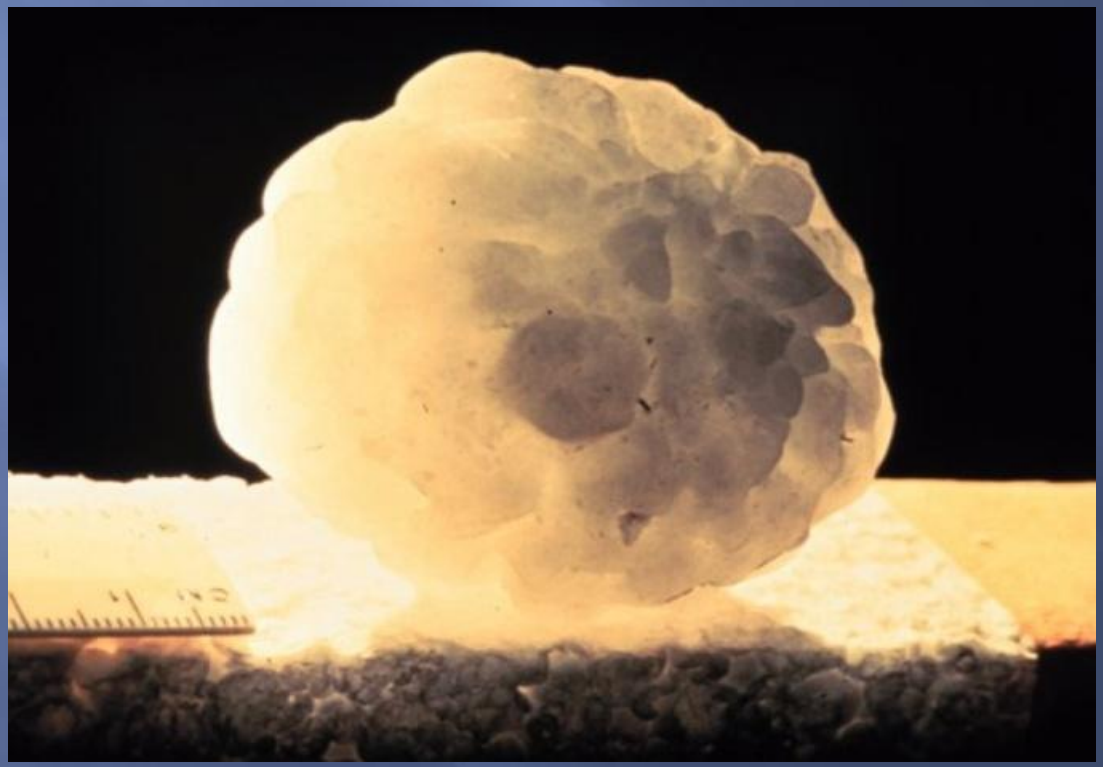
Hail Producing Thunderstorm



Cross-section of a Hail Stone

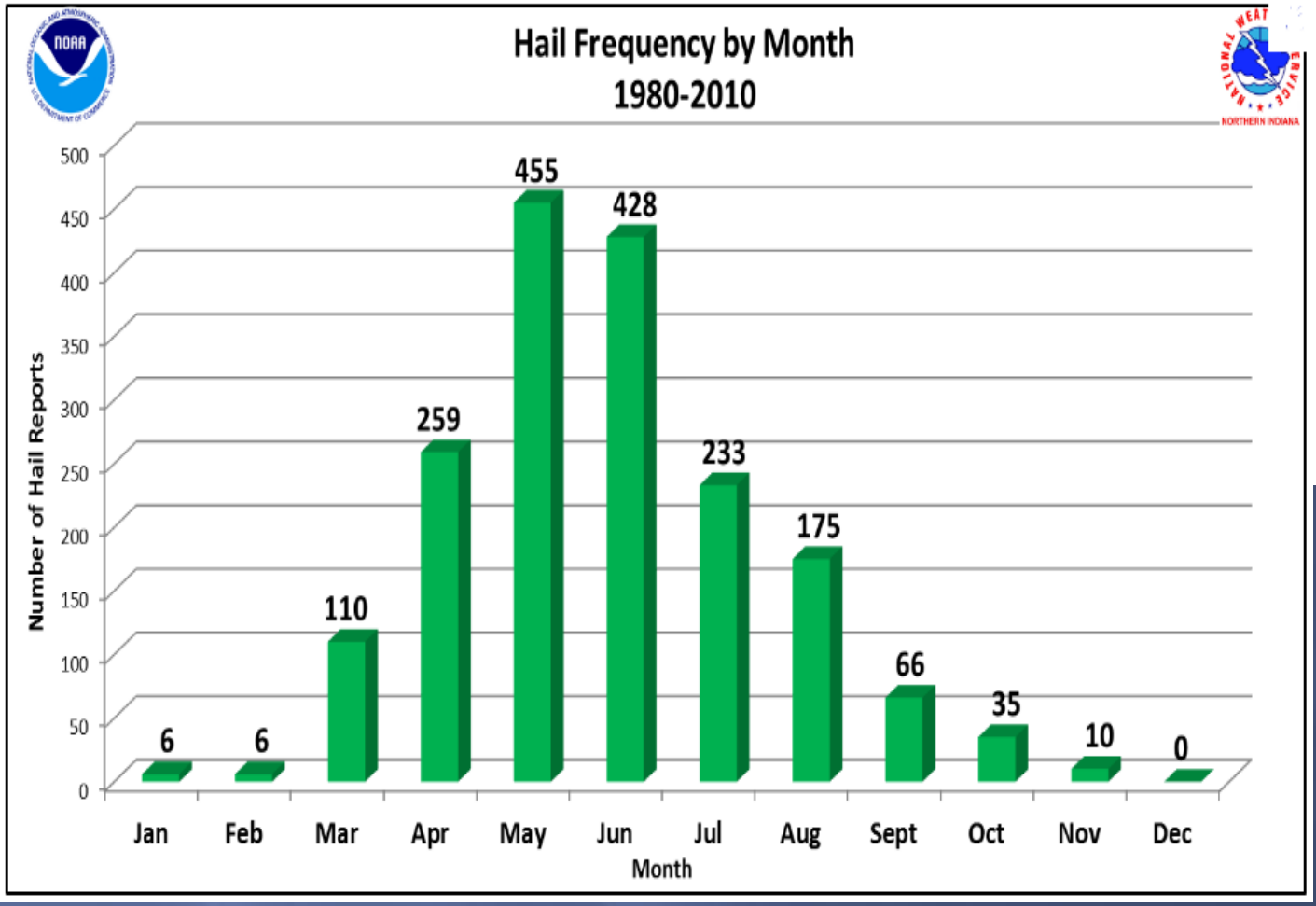
Hail Size

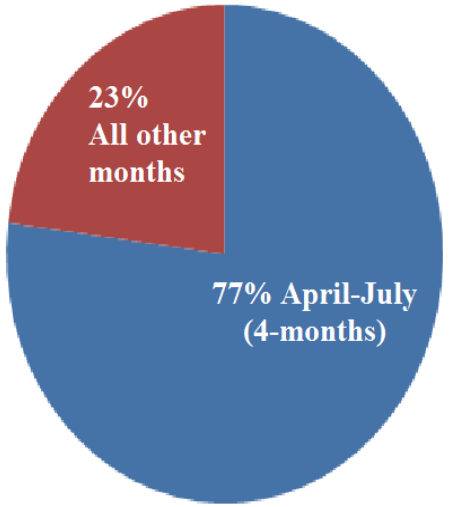
- 1) Depends on updraft strength
- 2) Depends on fall and re-fall depth
- 3) Depends on cloud liquid water
- 4) Aggregated hail efficiency



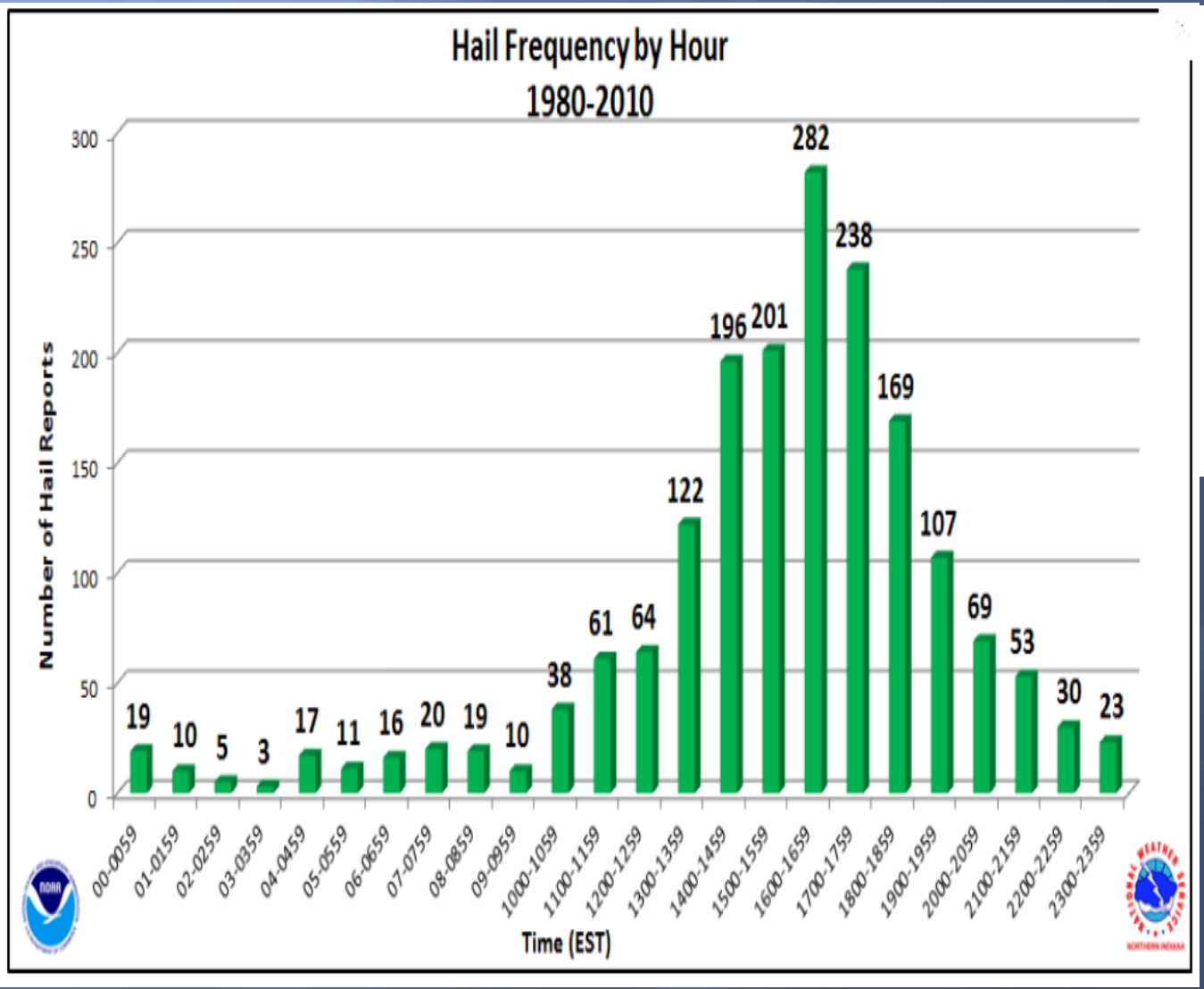
Hail Size Spectrum & What is Typically Reported

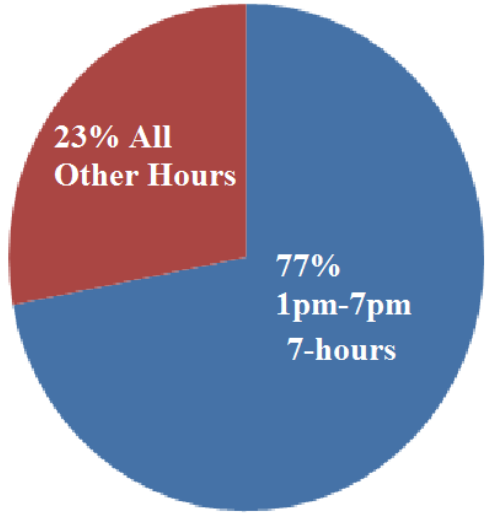
U.S. Hail Statistics by Month
(Max April-July)





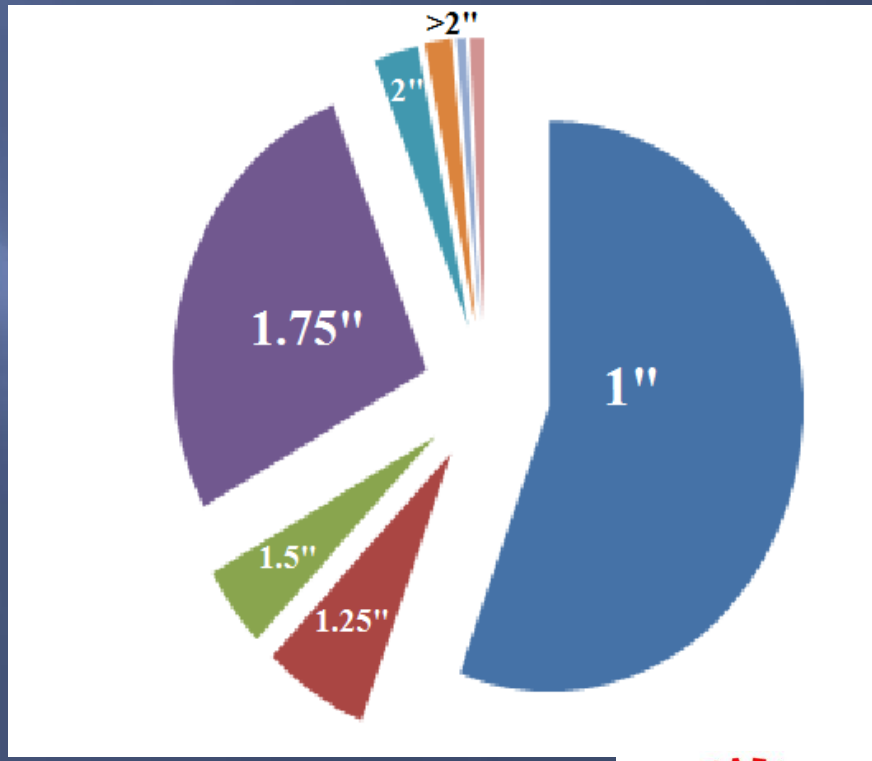
U.S. Hail Statistics by Hour
(Max 1-7pm)





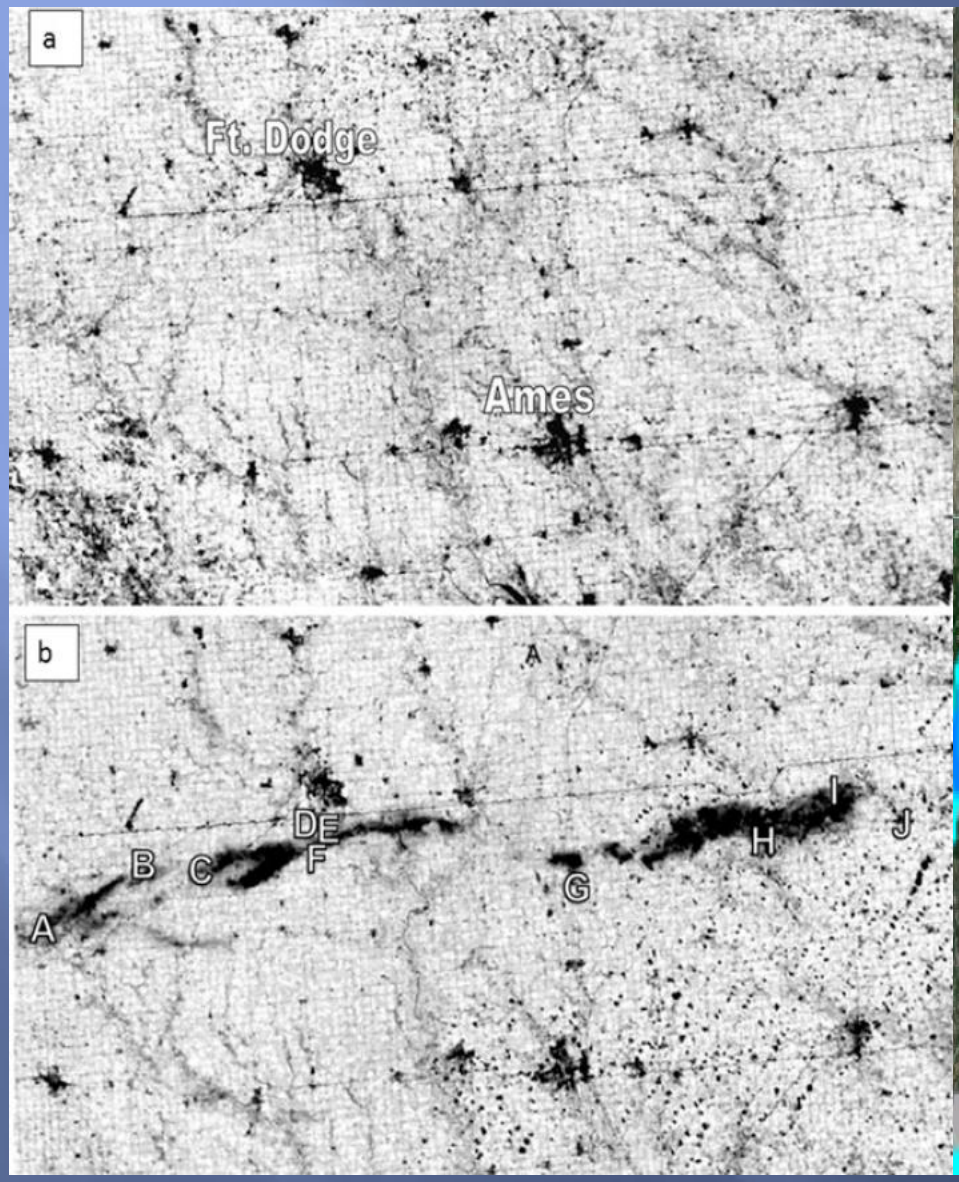
Hail reports by size
(from Hail Reporter)

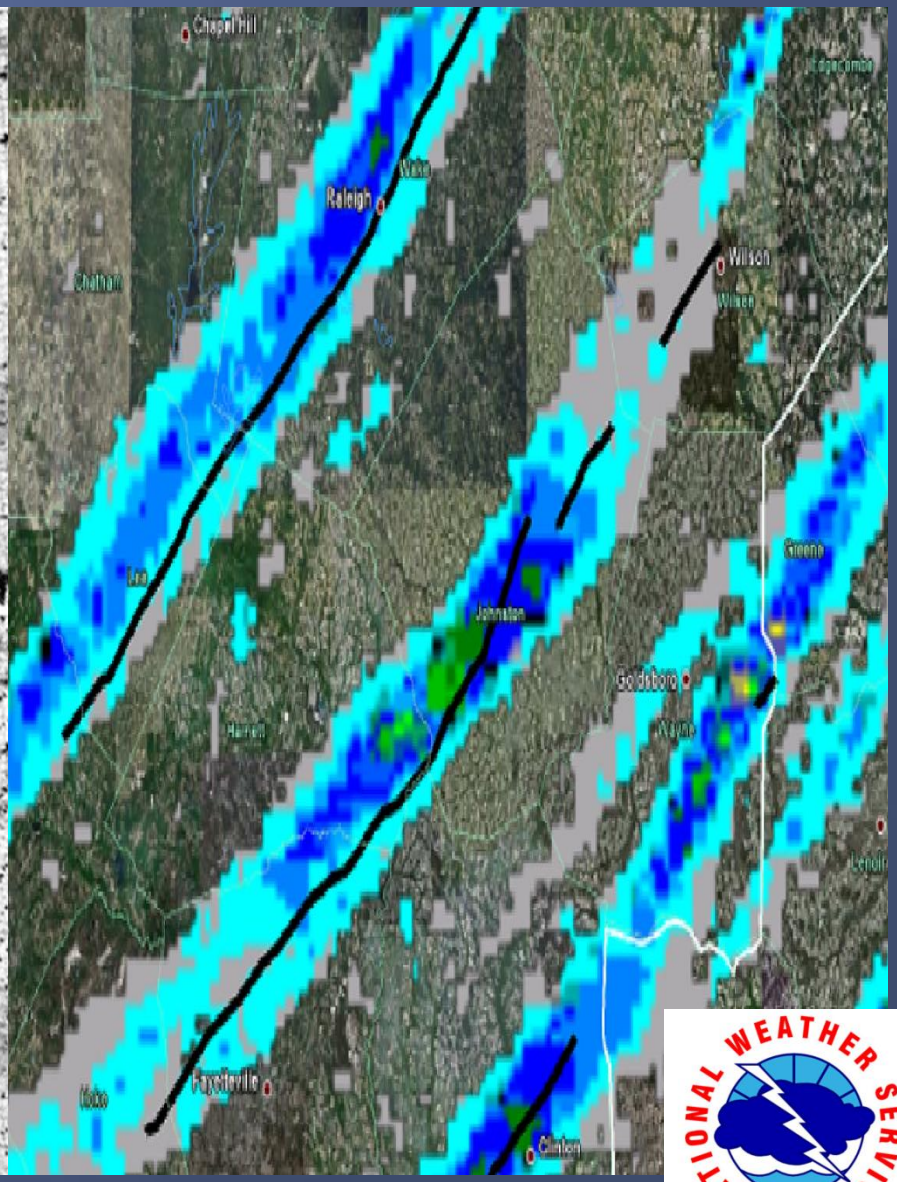
- ~ 5800 NWS Hail Reports per year US 48
- 1″ ~3000
- 1.25″ ~360
- 1.5″ ~ 250
- 1.75 ~ 1450 golf ball
- 2.00 ~ 150
- 2.5″ ~ 90
- 3.0″ ~ 35
- Greater than 3″ ~48



Hail Damage Swath Sizes

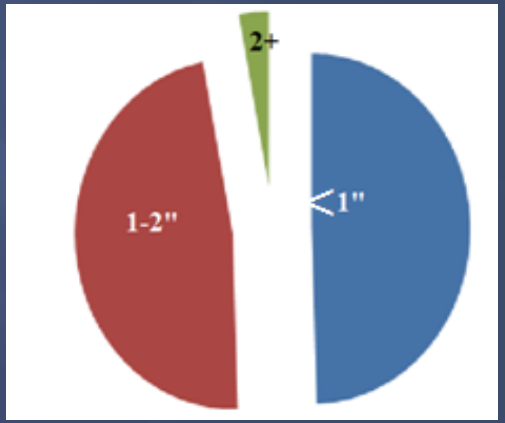
(left images from Gallo et.al)





NWS Hail Statistics

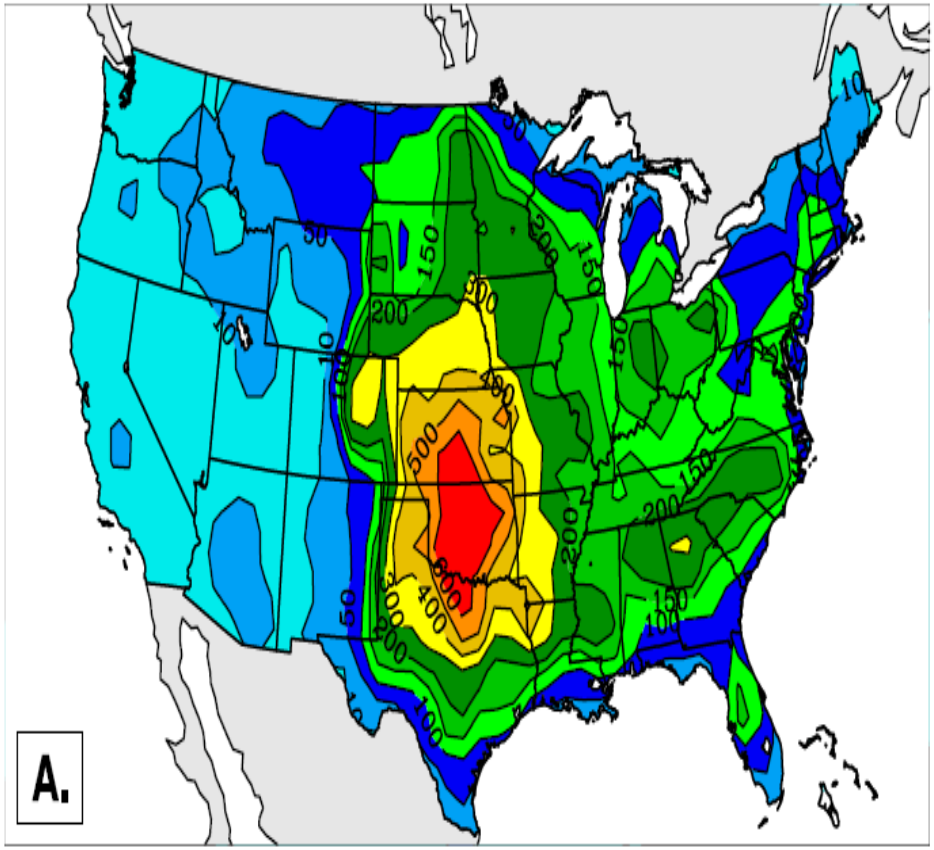
- In the average year, NWS gets ~ 10,000 to 12,000 hail reports
- Since January 1, 2010, NWS changed hail warning size to 1" from ¾". This change was because hail smaller than 1" not usually associated with significant damage.
- Reduced severe thunderstorm warnings of hail
- Smaller than 1" in size: 49% of reports
  Smaller than 2" in size: 96% of reports
  Smaller than 3" in size: 99% of reports



Primary Hail and Large Hail Areas

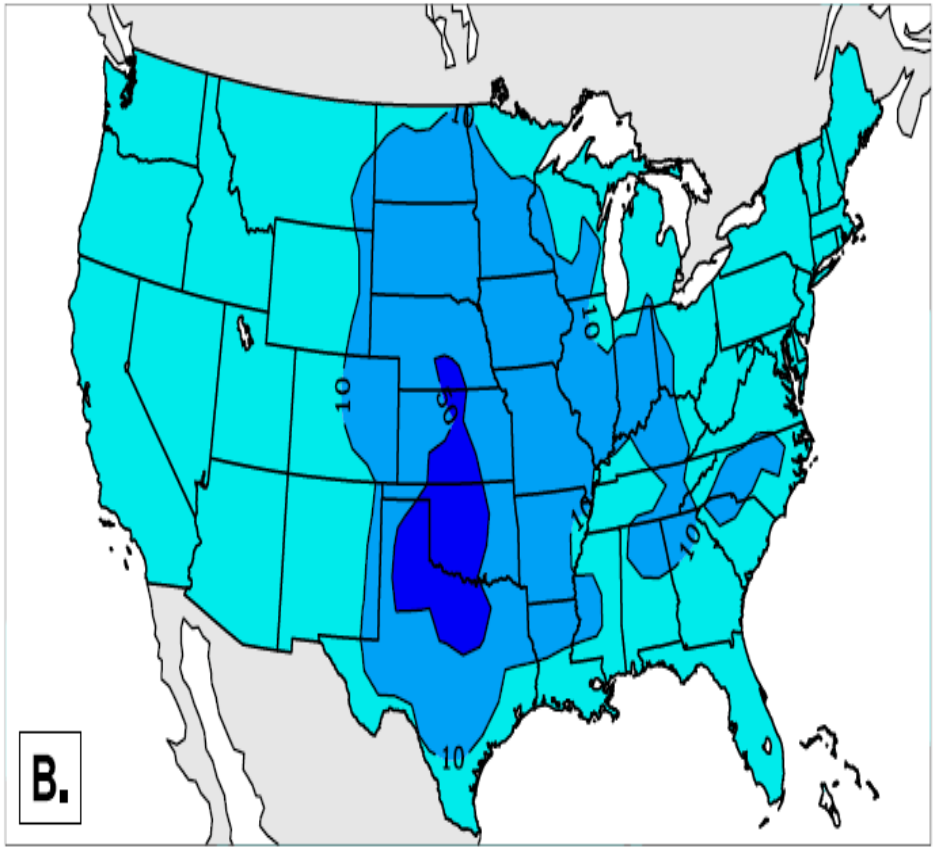
(from Schaefer et. al 2009)

Total Hail Reports, 1955-2002



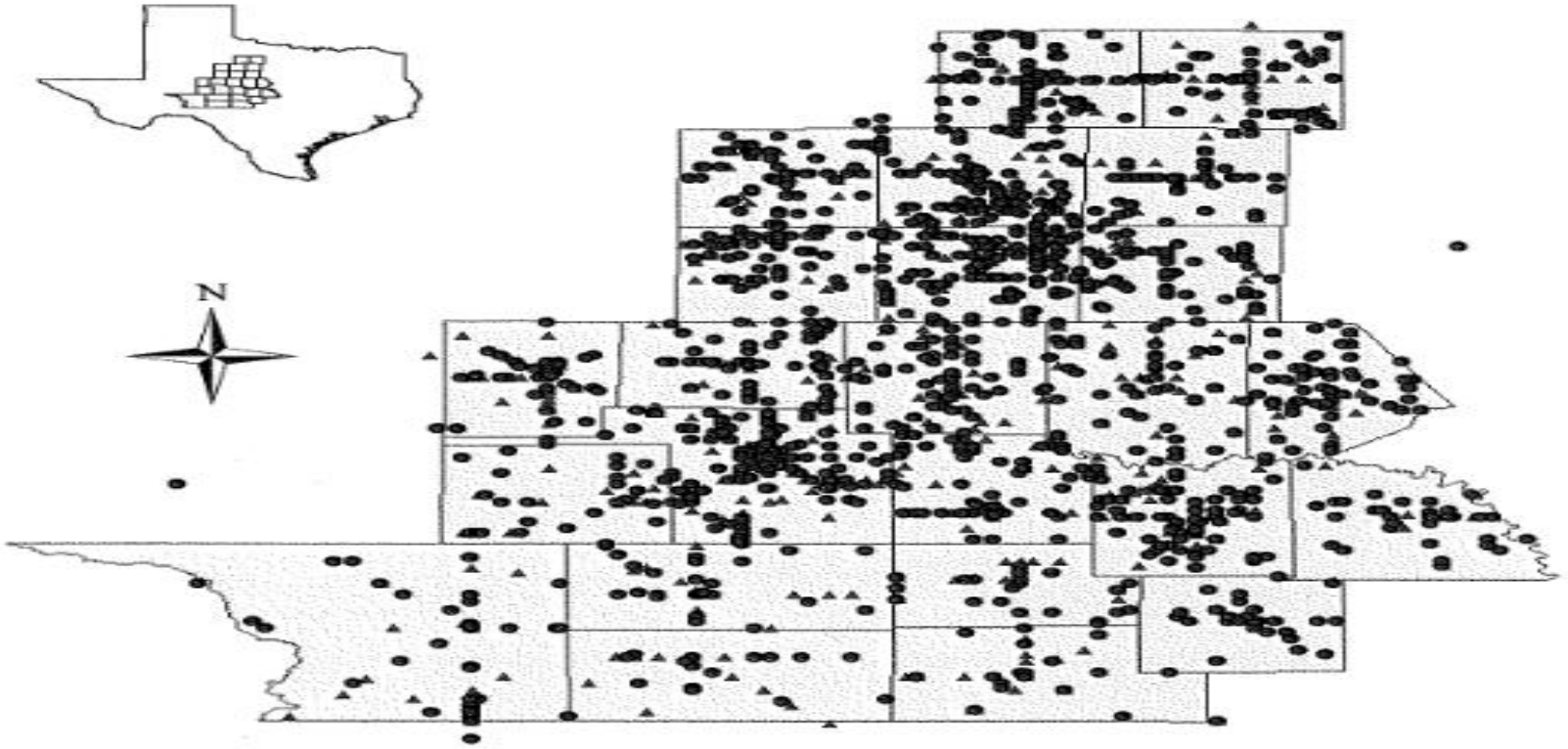
reports per decade per 10,000 nim^2

Total Hail (≥2 in) Reports, 1955-2002

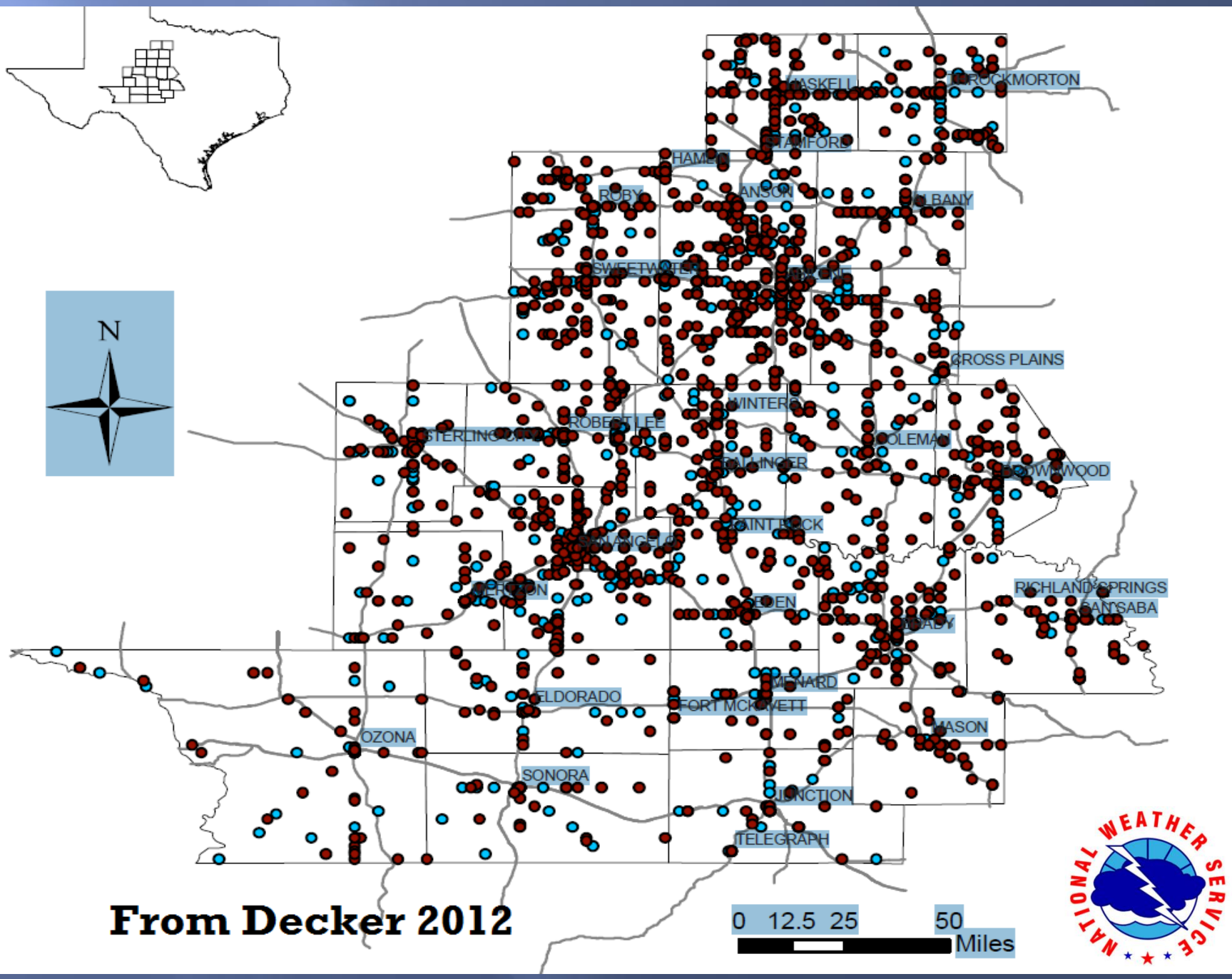


reports per decade per 10,000 nim^2

San Angelo CWA
1955-2008 Hail Reports



Source: Storms Prediction Center
Severe Weather Database Files (1950-2008)
http://www.spc.noaa.gov/wcm/#data
July 2009
Produced by Michael Decker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HASKELL
ROCKMORTON
STAMFORD
HAMLIN
RUBY
ANSON
ALBANY
SWEETWATER
COLORADO CITY
GROSS PLAINS
WINTERS
ROBERT LEE
STERLING CITY
COLEMAN
BALLINGER
BROWNWOOD
SAINT JOHN
SAN ANGELO
RICHLAND SPRINGS
SAN SABA
EDEN
MENARD
OLDORADO
FORT MCKAVETT
MASON
OZONA
SONORA
JUNCTION
TELEGRAPH
From Decker 2012
0 12.5 25 50
Miles
NATIONAL WEATHER SERVICE

Hail Frequency from Reports

(from Cintineo et. al. 2011)

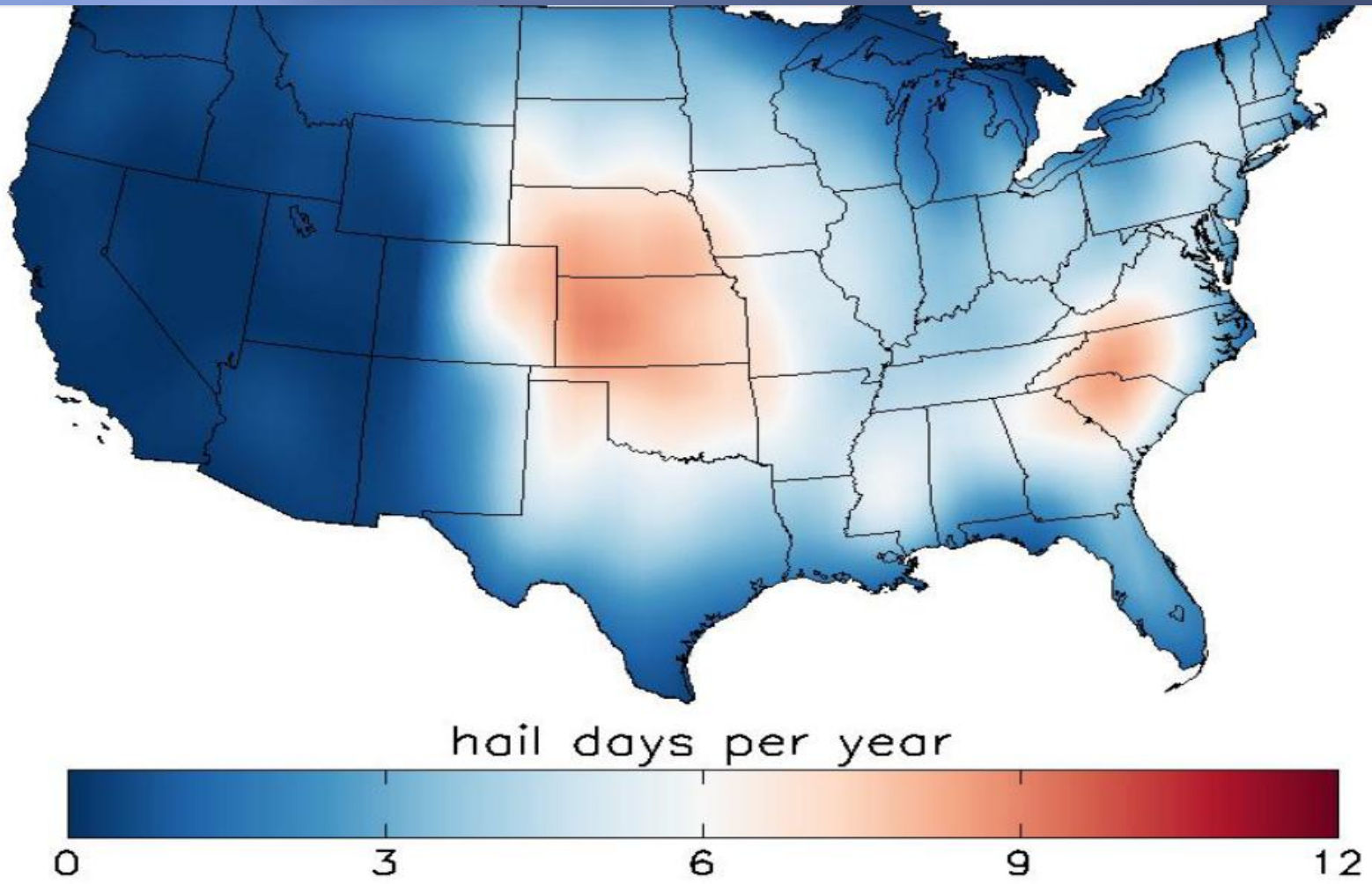
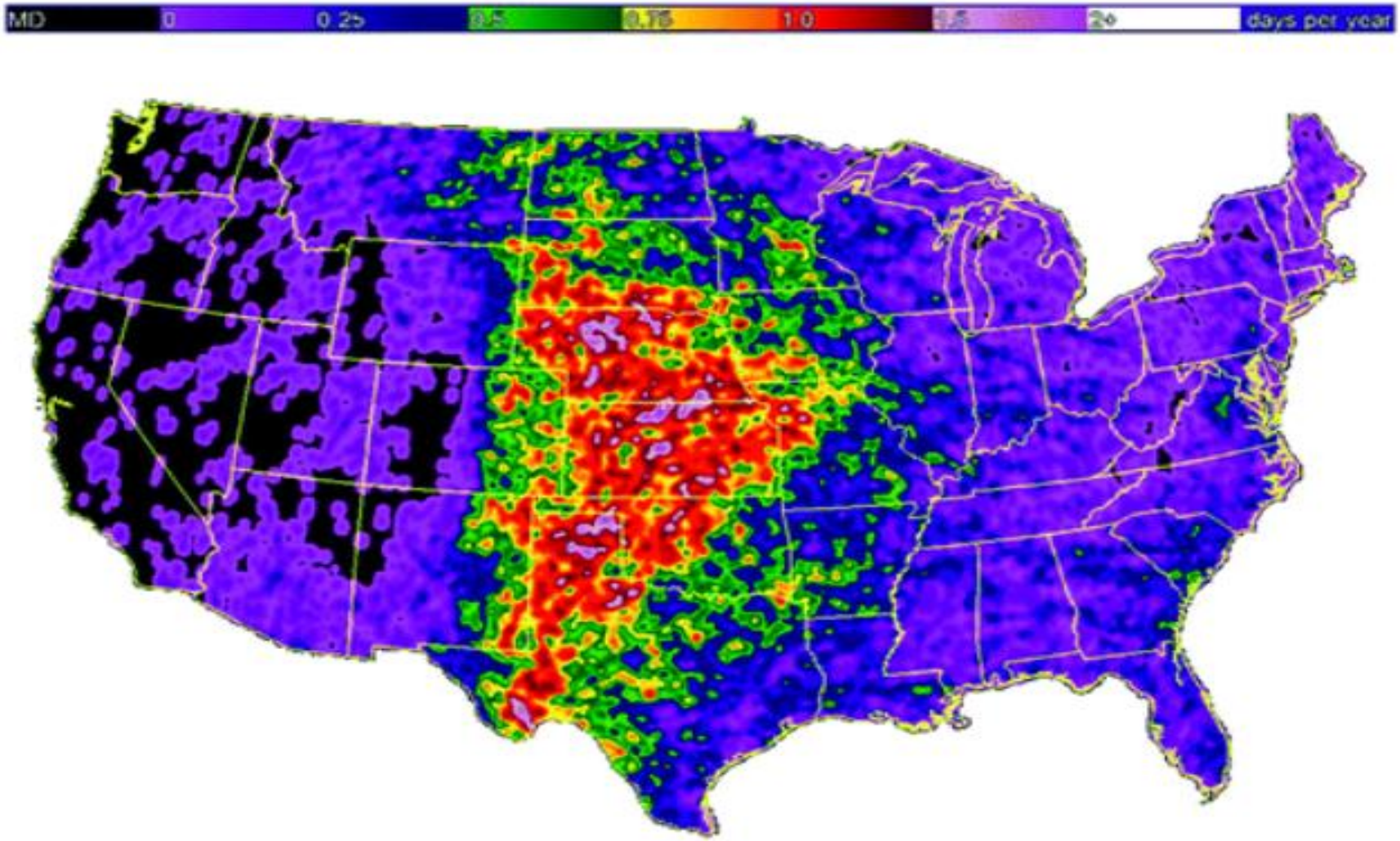


FIG. 10. As in FIG. 9, but with reports-based criteria.

Hail Days Per Year

(from Cintineo et.al 2011)

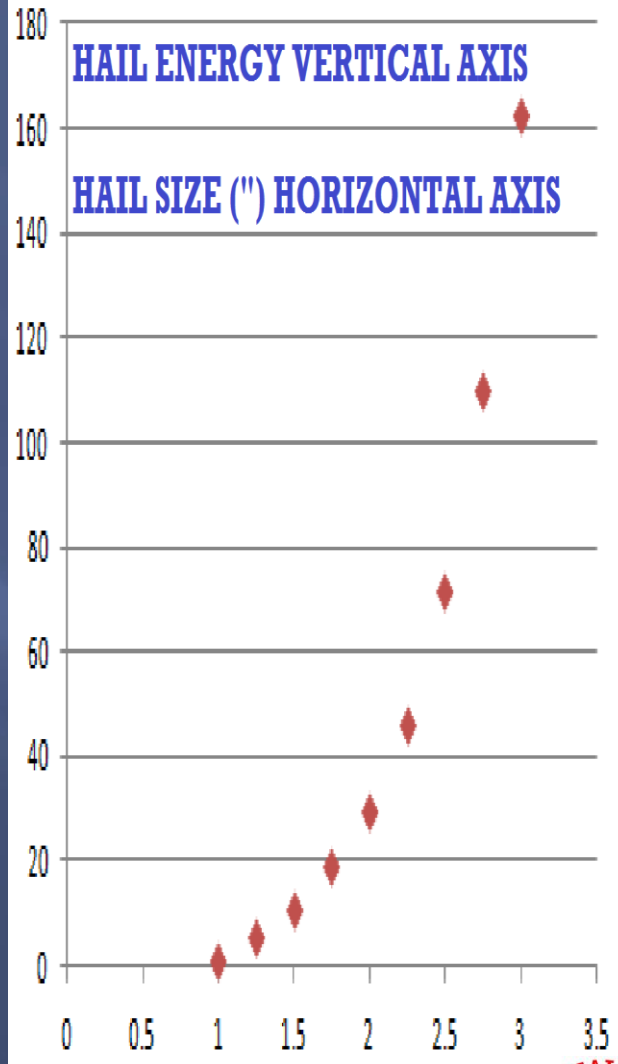


Annual hail days per year during 2007–10.

Hail Velocity & Energy

Diameter		Terminal Velocity		Impact Energy	
in.	cm	mi./hr.	m/sec.	ft.-lbs.	Joules
1	2.5	50	22.3	<1	1.36
1.25	3.2	56	25.0	4	5.42
1.5	3.8	61	27.4	8	10.85
1.75	4.5	66	29.6	14	18.96
2	5.1	72	32.0	22	29.80
2.25	5.8	76	34.0	34	46.01
2.5	6.4	80	35.7	53	71.90
2.75	7.0	84	37.6	81	109.8
3	7.6	88	39.6	120	162.7

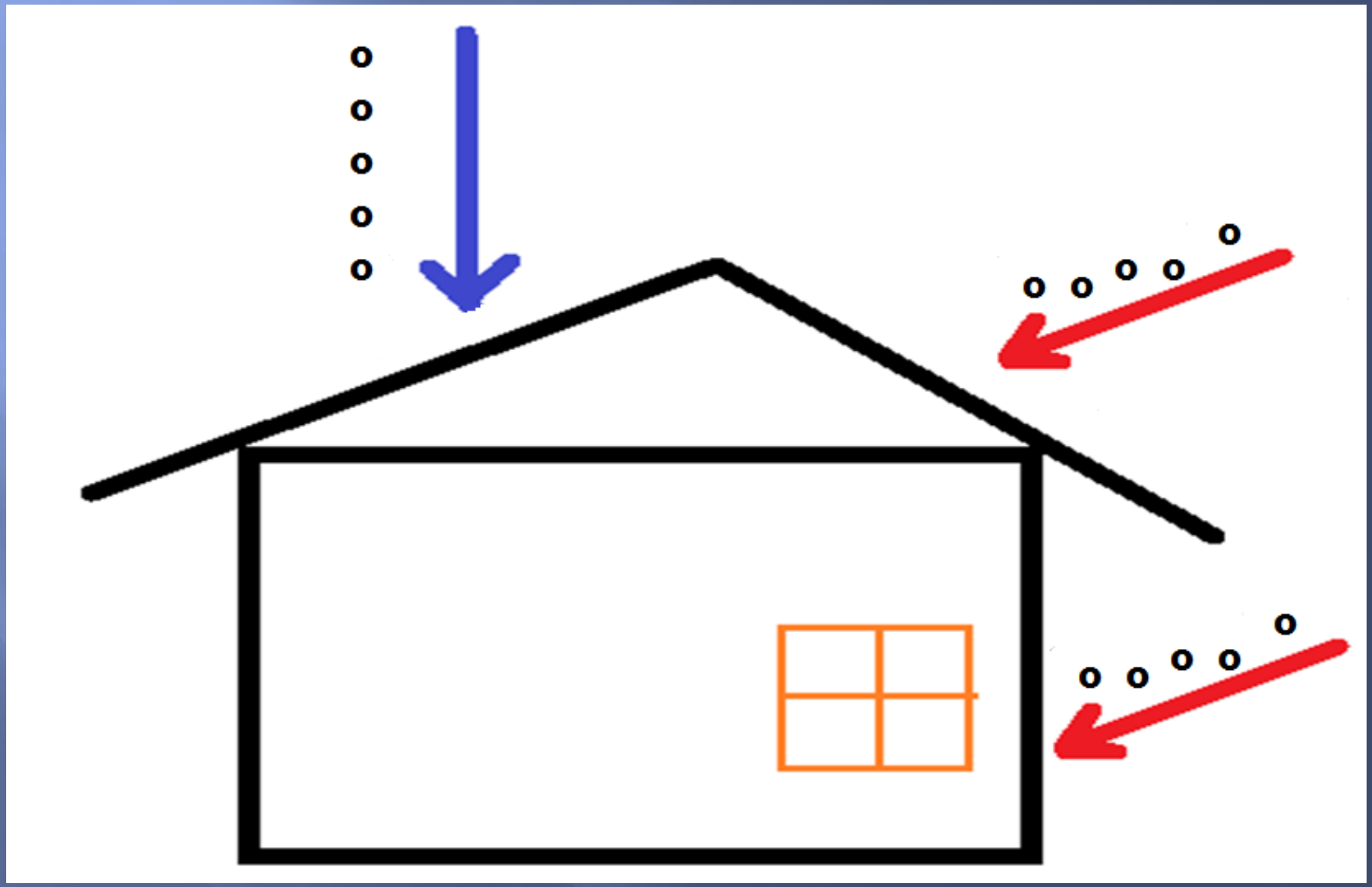
Table 1. Terminal velocities and energies of hailstones (after Greenfeld, 1969).



Downbursts & Microbursts

Hail damage is also controlled by hail firmness!

Hail fall angle & fall velocity are controlled by hail size, hail shape & WIND



Wind-blown Hail Damage

Hail Damage- Structures vs Vegetation

- Structure Damage easier to quantify
- Vegetation damage is highly dependent upon:

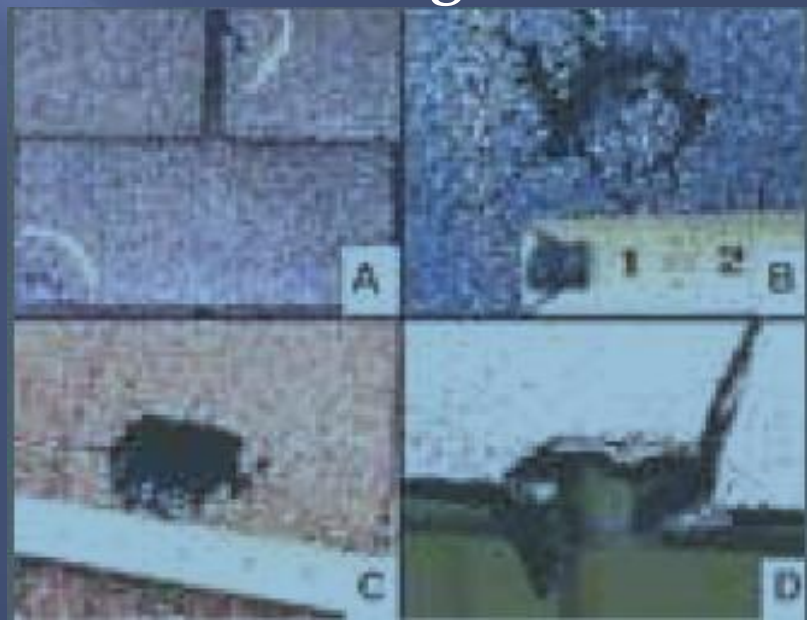
1) Plant type/size
2) Plant maturity
3) Plant exposure & plant wetness
4) Plant resistance to impact

Nectarine vs Cherry

- Hail damage to asphalt shingles- severe granule loss, material removal at the edges & penetration.

- New asphalt shingles are more resistant to hail impact than older shingles since asphalt becomes more brittle with age.

- Warmer shingles are more compliant and resistant to fracture from hail compared with colder shingles.



- Flexible roof sheathing allows shingles to flex during impact causing damage.

- Rigid roof sheathing supports the shingle during impact resulting in less shingle damage.

NWS 1-inch criteria for Severe Thunderstorm Warning…

(Marshall et. al. 2010)

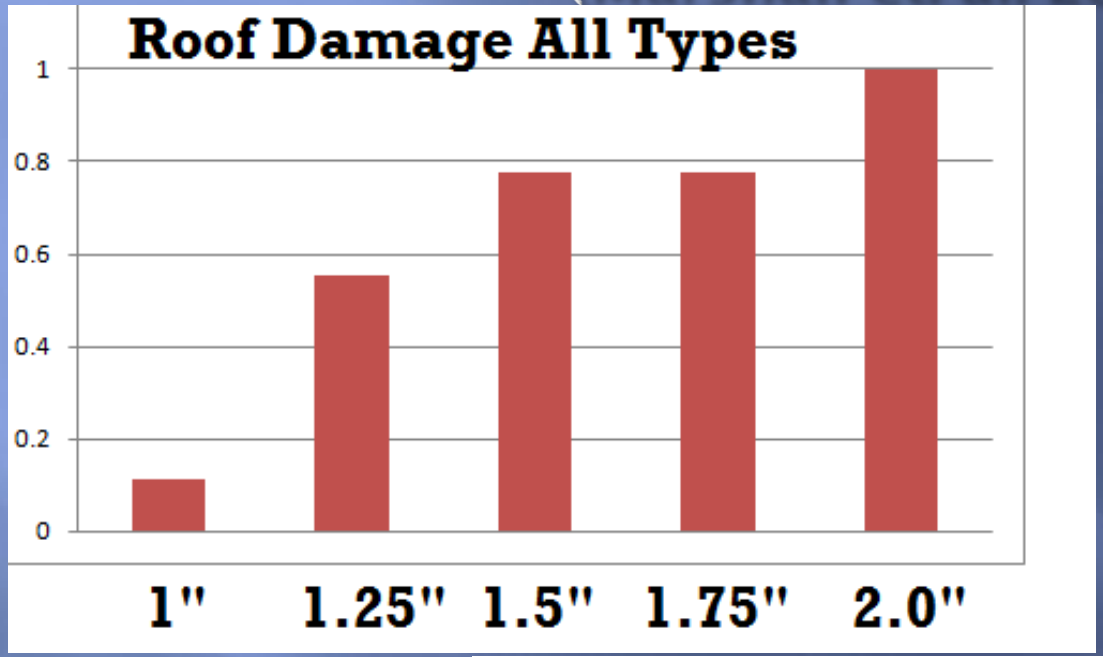


Figure 3. Ice ball launching (IBL) device with light sensors (chronograph) developed for impact testing.

Type of Roofing Product	Age (yrs)	1 in. (25 mm)	1.25 in. (32mm)	1.5 in. (38mm)	1.75 in. (44mm)	2.0 in. (50mm)
3-tab fiberglass shingles	11	0	60	90	100	100
3-tab organic shingles*	11	50	90	100	100	100
30 yr. Laminated shingles	11	0	0	60	90	100
Cedar shingles	11	0	30	80	100	100
Heavy cedar shakes	0	0	0	50	90	100
Fiber-cement tiles	0	0	20	80	100	100
Flat concrete tiles	0	0	20	50	50	100
S-shaped concrete tiles	0	0	0	0	0	80
Built-up gravel roofing	8	0	0	0	0	30
Number of Products Damaged		1/9	5/9	7/9	7/9	9/9

*no damage at .75 inch.

Table 2. Ice stone impact test results for various roofing products. Percent of damage is indicated.


LIVE
HAIL STORM
FIL ALVARADO
EAST DALLAS
FOX
4
10:01 88°

Conclusion

"Since hail storms can cause billions of dollars in property damage and agriculture loss each year, ways to minimize their impacts should be a high priority for meteorologists who forecast them, for scientists and engineers developing new products to withstand them and for the commercial builders who use those products," Lyons said.

THANK YOU

- EXCELLENT SITE TO GO FOR BUILDING MITIGATION ESPECIALLY FOR THE PUBLIC- FLASH.org

- HAIL INFORMATION IS HERE-

http://flash.org/video.php?id=21

Massive Hail & Flood Amarillo-Dumas TX June 2012